Development of Physics-Based Numerical Models for Uncertainty Quantification of Selective Laser Melting Processes

Research Team

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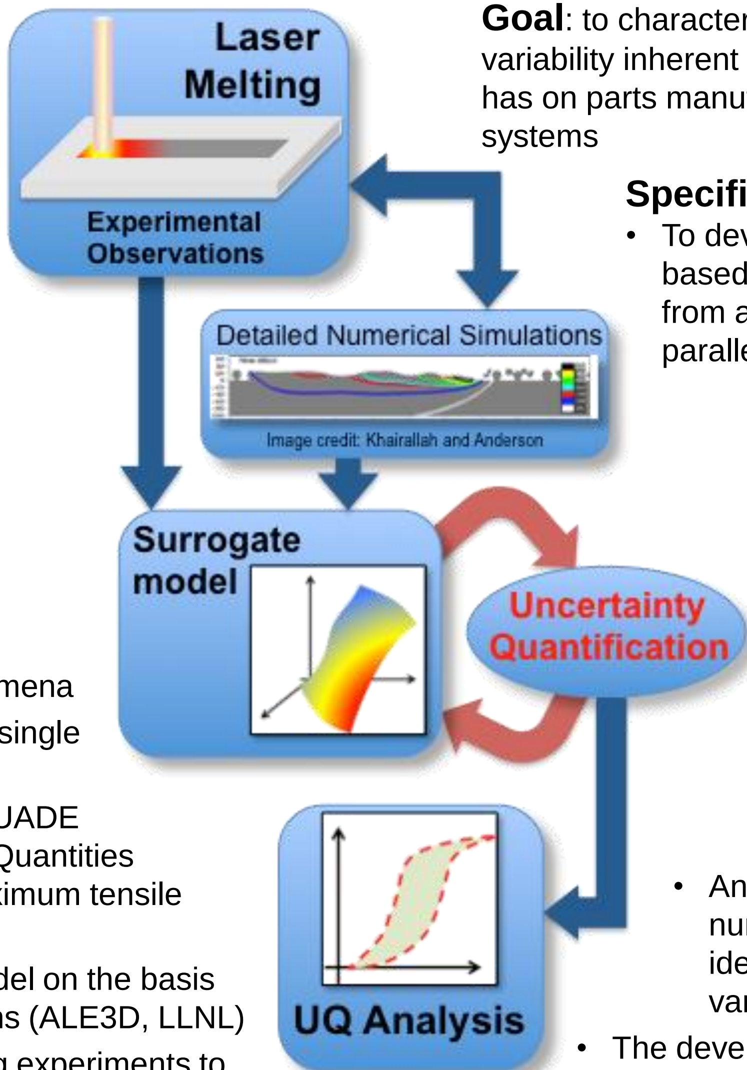

Research Objectives

Goal: to characterize the effect that process parameter variability inherent to the Selective Laser Melting (SLM) process has on parts manufactured using that technique for space flight systems

Specific objectives:

- To develop, verify, and validate robust physics-based SLM models leveraging powder-scale results from a DOE multi-physics, multi-scale massively parallel code (ALE3D).
- To quantify the uncertainty in the prediction of material density and maximum tensile residual stress during SLM of cubic coupons.

Approach

- Focus on the melt-pool/powder-scale \phenomena
- Consider simple configuration (single track and cubic coupons)
- Develop UQ strategy using PSUADE (LLNL) and surrogate models. Quantities of interest are: density and maximum tensile residual stress.
- Develop surrogate process model on the basis of detailed numerical simulations (ALE3D, LLNL)
- Perform controlled laser melting experiments to validate numerical models

Potential Impact

- The proposed project is a necessary step toward a scientifically-based numerical prediction of the SLM process which will enable the certification of components manufactured using SLM techniques for use in mission-critical roles.
- An important outcome will be a path to predictive numerical simulation of SLM processes and the identification of strategies to mitigate part variability.
- The development of the surrogate model will also provide insight and guidance for the future development of reduced-order models